
Winter Climate Adaptation Measures for the Chicago Metro Region

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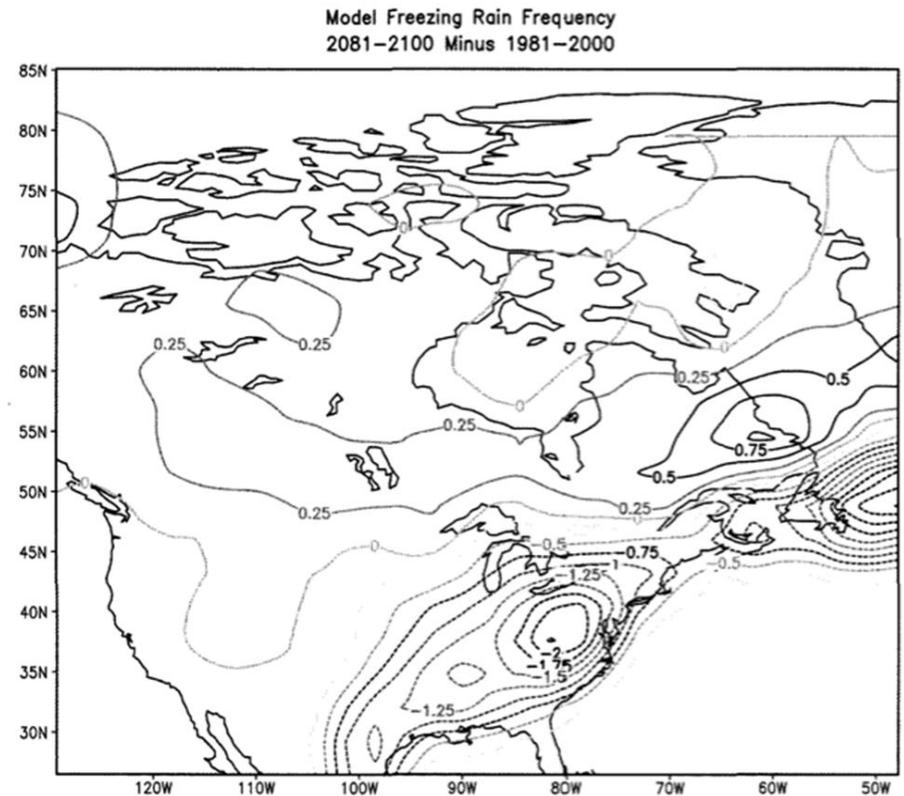


Objectives

- Review the likely future winter climate changes affecting the Chicago metro area.
 - Recommend specific adaptation measures to enable CMAP to address these issues in the revision of its *Go To 2040* regional plan
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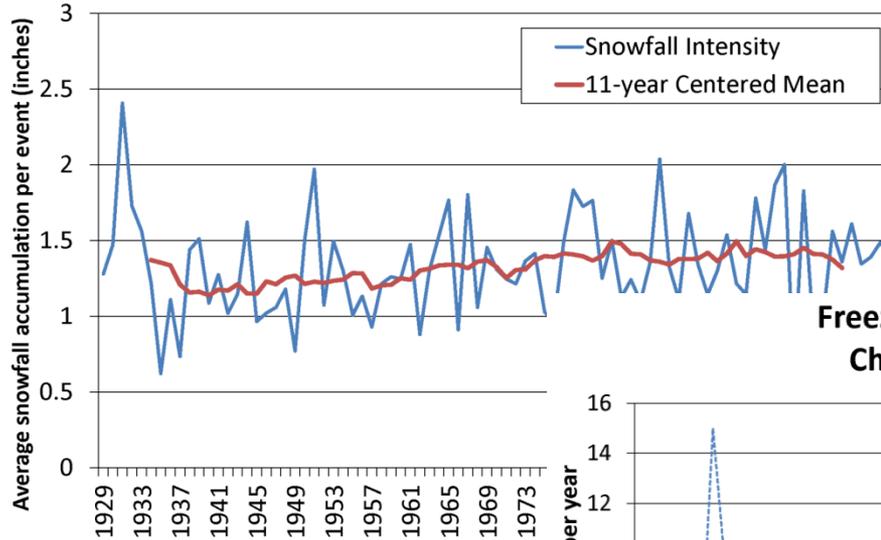
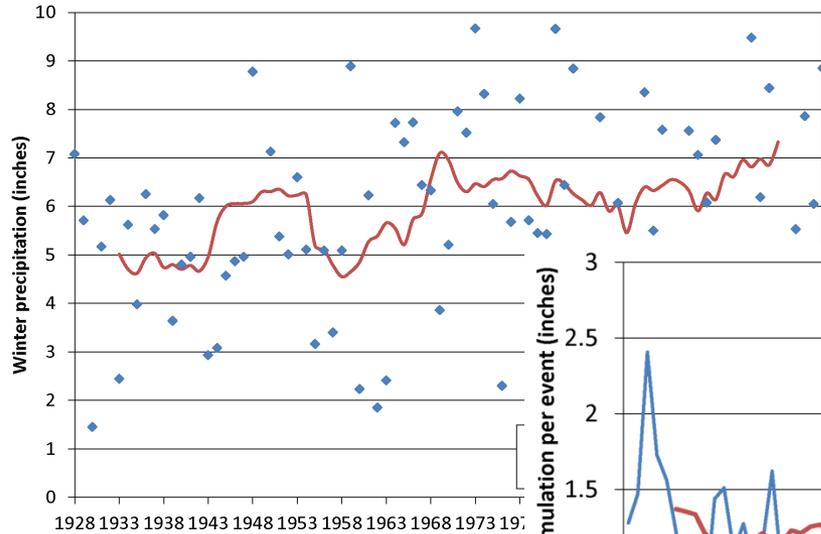
Winter Season Climate Information

- Winter Climate Data and Trends
 - Winter Precipitation
 - Snowfall Intensity
 - Freezing Rain & Ice Storms
 - Snow Density
 - Freeze-Thaw Events



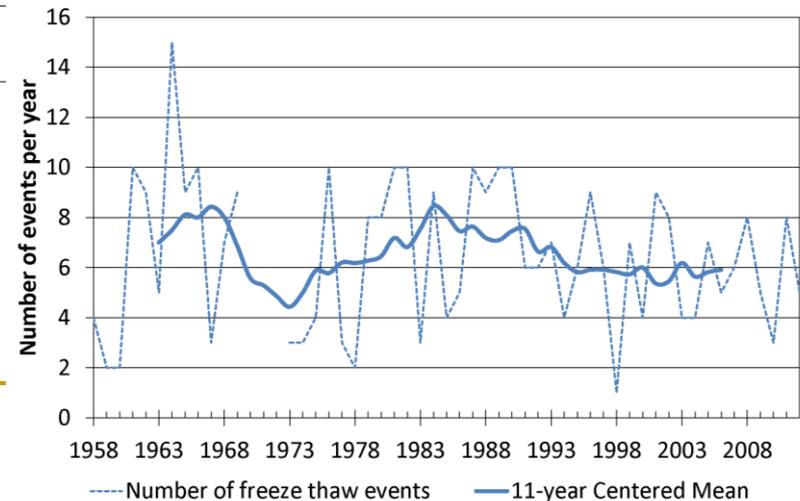
Analyses of MRCC's Historical Data

Winter Precipitation
Chicago Midway

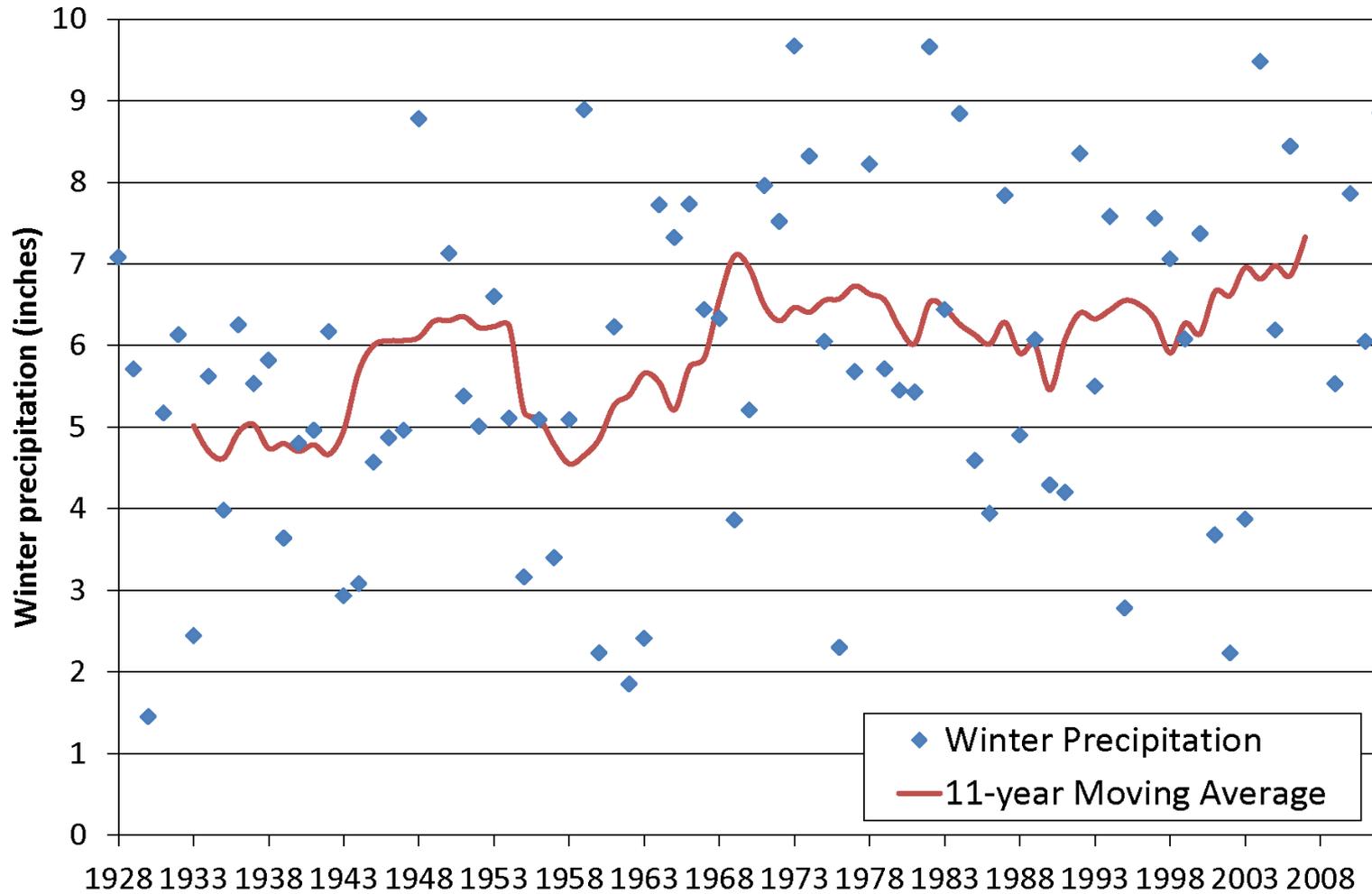


Source: Midwestern Regional Climate Center

Freeze-Thaw Events
Chicago O'Hare



Winter Precipitation Chicago Midway

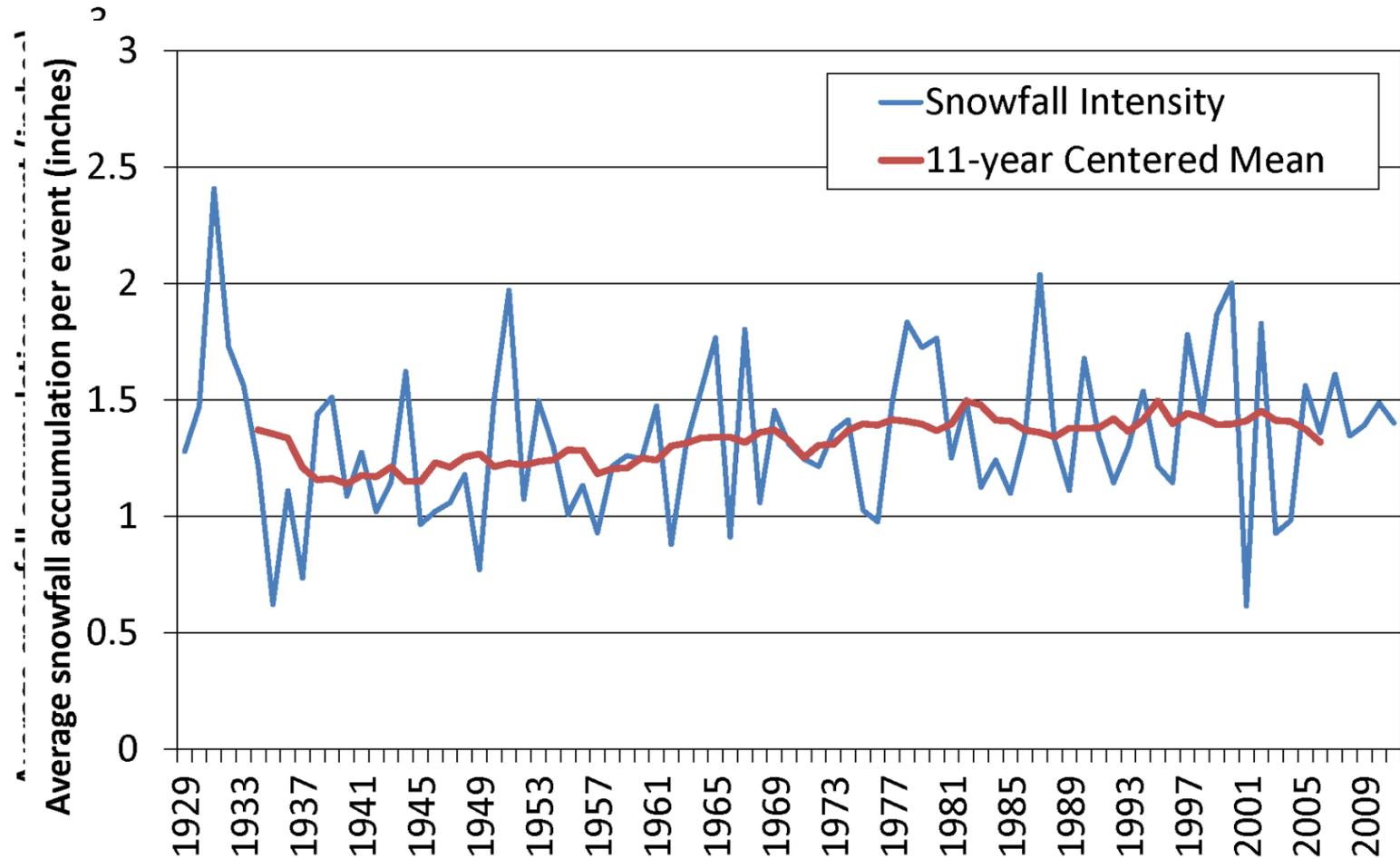


Source: M. Woloszyn (2013)

More Winter Precipitation Projected

- National Climate Assessment claims **more precipitation** can be expected during the winter, because warmer winter air temperatures allow more humidity to be retained in atmosphere
- Any additional winter precipitation may likely be in the form of **more rain** not snow:
 - Under a lower emissions scenario, there **might not be a drastic change in total amount of annual snowfall.**
 - Under a higher emissions scenario, **average winter snowfall in Chicago could drop by about 10 inches** by the end of the 21st century.

Will the Fewer Snowstorms be Larger?



Source: Midwestern Regional Climate Center

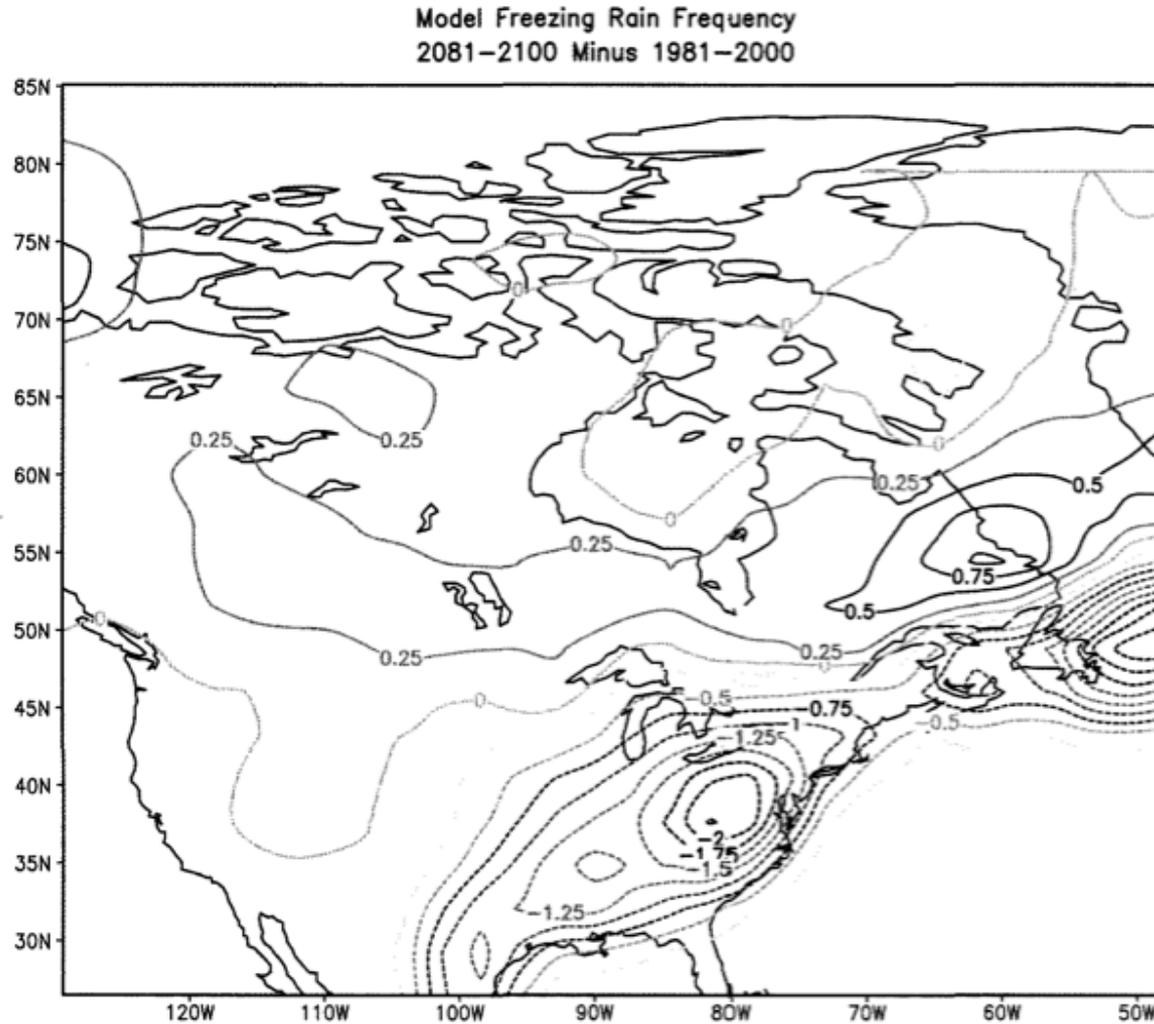
Snowfall Intensity – Future Trends

- Historical data trends not strong enough to be statistically significant
- Future projections based on theory, not data:
 - Climate models predict **number of snowfall days may decrease** in future (especially under mid- to high-emissions scenario)
 - But, they also predict that **precipitation intensity is expected to increase** due to a higher moisture-capacity of the atmosphere
 - Therefore, it is expected that **a higher accumulation of snowfall will be associated with snow events when they occur**

Freezing Rain Projections

- Historically, from 1948-2000, the Chicago region averaged **about 3 or 4 freezing-rain events per year**
- GLISA found one study (Lambert and Hansen 2011) predicting that **freezing-rain activity may decrease by about one event per year** in the Chicago region (see following slide)
- **Decrease might be even larger** since, in using models to look at future freezing-rain scenarios:
 - Lake-effects are not represented in GCMs
 - Urban heat island effect is not represented in GCMs

Less Freezing Rain Expected



Source: Lambert and Hansen (2011)

Snow Density – Historical Trends

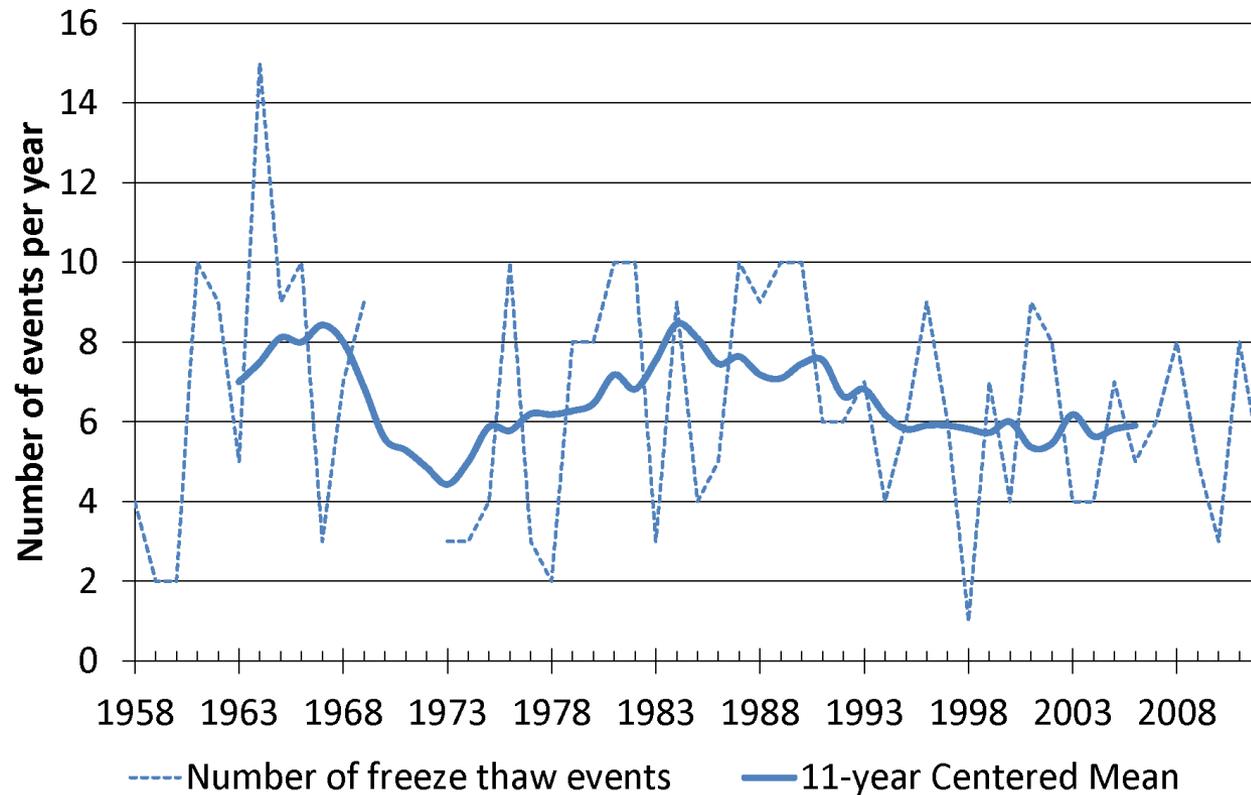
- Density = ratio of liquid water content of snow
 - Heavy snow = 1:1 <ratio<9:1
 - Average snow = 9:1 <ratio<15:1
 - Light snow = ratio > 15:1
- Colder the temperature, the lighter the snow (and the more it can drift); the warmer the temperature, the wetter and heavier the snow
- Historical trends: “average” snow density events have been increasing (with both light and heavy snow frequency declining)

Snow Density – Future Projections

- Very few studies have examined snow density
 - **Theoretically**, the following might occur:
 - With warming winter air temperatures, if snow does occur (as opposed to rain/freezing rain), **the frequency of heavier, denser snow events may increase.**
 - **This conclusion has not been modeled**, but is based on basic theory and projections of winter temperature increases
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Freeze-Thaw Cycles

Freeze-Thaw Events Chicago O'Hare



Source: M. Woloszyn (2013)

Freeze-Thaw Events

- Defined as where air temperature, as measured above 1-cm of bare soil, fluctuates between 26° F and 43°F in any given year
 - Historical trends: Statistically **decreasing trend in the number of freeze-thaw events** in Chicago area (which currently average about 6.5 events/year)
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Freeze-Thaw: Future Projections

- Few studies available for the Midwest, but **in theory**, reduced snow pack with warmer winters should result in **more freeze-thaw events**
 - Canadian freeze-thaw study (Henry 2008):
 - Harrow, ON -- which is the closest monitoring station in the study, and is located at about the same latitude as Chicago -- receives 6-7 freeze-thaw cycles/year
 - Modeling suggests Harrow is expected to experience 11-12 freeze-thaw cycles by 2050
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Major Winter Impacts for Metro Area

■ **Warmer Winters**

- **Little change in annual energy costs**, since warmer winter heating savings offset by higher summer air conditioning expenditures
 - Average Chicago household would save only ~ \$48 in its energy costs by mid-century (at current energy prices)
 - May also not change GHG emissions rates, since summer peak energy use may increase (with higher associated air pollution risks during ozone season)
 - **Likely fewer ice storms and freezing rain events**
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Major Winter Impacts II

- **More intense winter precipitation events**
 - **Fewer, but larger and denser, snowstorms** = more tree damage and power failures (but can't assess from ICC records), more health risks (from snow shoveling & power blackouts), fewer road closures (less drifting) and less deicing-salt use
 - **More winter precipitation as rain** = increased flood risks (more rain falling on snow and frozen ground, decreased on-site stormwater storage capacity from snow storage, and decreased green infrastructure performance) and water quality impacts (but less salt and spring pollutant loading)

Major Winter Impacts III

- **More freeze-thaw cycles likely** (possible doubling of freeze-thaw days/year by mid-century?)
 - More roadway damage (more potholes, especially around utility cut patching, frost heaves, etc.)
 - More damage to concrete and masonry structures
 - Failure of structural fasteners or building cladding
 - Ice falling from facades and from projections over sidewalks (e.g., signs, balconies, etc.)
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Recommendations

■ **Warmer winters**

- Increase number of indoor skating rinks and indoor sports and events programming by park districts/depts. and forest preserves
 - Plan for more marina and harbor dredging, shoreline structure maintenance, and beach nourishment from increased frequency of extreme weather events
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Recommendations (con't)

■ **More freeze-thaw events**

- Improved inter-departmental coordination with respect to infrastructure repair and replacement and roadway resurfacing projects
 - Minimize asphalt patching on concrete streets
 - Schedule subsurface infrastructure replacement when road being resurfaced
 - Increase permeable paving use?
 - Increase structural inspection frequency of vulnerable buildings (e.g., terra cotta cladding)
 - Minimize/eliminate projections over sidewalks with high pedestrian counts (or increase arcade bonus)
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Recommendations (con't)

■ **More heavy, wet snow**

- ❑ Change plowing operations (less deicing salt use)
- ❑ Revise on-site BMP design guidelines for urban stormwater management to increase MOS (especially where stormwater detention/infiltration areas are also used for temporary snow storage)
- ❑ Revise planting lists to select street tree species less susceptible to ice and heavy snow damage
- ❑ Revise electrical utility franchise agreements to require increased tree trimming near power lines
- ❑ Establish emergency heating centers and food safety guidelines for winter power blackouts